

APPARENT TRANSPIRATIONAL RHYTHMS OF *AVICENNIA MARINA* (FORSK.) VIERH. AT INHACA ISLAND, MOÇAMBIQUE

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ABSTRACT

The potometric method was used to investigate the apparent transpirational rhythms of *Avicennia marina* (Forsk.) Vierh. in the Ponta Rasa mangrove swamp on Inhaca Island. The increase in transpiration rate to a maximum at 10h00, followed by a steady decrease, confirmed findings by other workers. However, inundation of mangroves by a spring tide did not reverse the decrease in rate during the late afternoon. Mangroves growing in a "dry" area inundated only during spring tides and in a "wet" area in which moisture was freely available to the trees showed no differences in apparent transpiration rhythm.

UITTREKSEL

SKYNBARE TRANSPIRASIERITMES VAN *AVICENNIA MARINA* (FORSK.) VIERH. OP INHACAEILAND, MOSAMBIEK.

Die potometriesie tegniek is gebruik om die skynbare transpirasieritme van *Avicennia marina* (Forsk.) Vierh. in die Ponta Rasa wortelboommoeras op Inhacaeiland te ondersoek. Die toename in transpirasietempo tot 'n maksimum om 10h00, gevolg deur 'n stadige afname, is ook deur ander navorsers vasgestel. Oorstrooming van die wortelbome deur 'n springetjy het nie 'n omkeer in die afname van die transpirasietempo in die laat namiddag tot gevolg gehad nie. Daar was geen verskil in die transpirasietempo van bome in 'n "droë" gebied wat slegs tydens springetjy oorstroom word, en die bome in 'n "nat" gebied waar vogtigheid altyd vryelik beskikbaar was nie.

INTRODUCTION

This research was conducted to provide more information on the pattern of transpiration in *Avicennia marina* which is probably the commonest of the mangroves occurring along the coast of Southern Africa. A previous study (Lewis & Naidoo, 1970) had been conducted during one of the cooler months of the year in Southern Africa, and it was felt that, for a more complete understanding, data for the hot summer months were necessary as well. For this reason a series of readings was conducted on Inhaca Island, Mocçambique, in January, 1974. Although this study confirmed the general pattern of transpirational rhythm which had been established previously, the rate was not influenced by the ready availability of free water for transpiration.

MATERIAL AND METHODS

The study was conducted in the Ponta Rasa mangrove swamp which was described by Mogg (1963). Young, healthy trees 2 to 3 m tall, bearing immature propagules, were used in this investigation. The ground vegetation comprised *Arthrocnemum* spp. and *Chenolea diffusa*.

The potometric method described by Lewis & Naidoo (1970), was used to determine apparent transpirational rhythm. Wherever possible, values represent the mean of readings obtained from two potometers, each attached to adjacent trees. Readings were taken on the hour, usually every hour, from 06h00 until 18h00, i.e. from just after sunrise until just before sunset. An exception was made in the experiment conducted on 24 January, when readings until 14h00 were taken at two-hourly intervals. Temperature and humidity measurements were obtained with a whirling psychrometer simultaneously with transpirational readings. The weather during the entire experimental period was hot with very little wind. There was no cloud except on 22 January, when temperatures were also slightly lower, and on 24 January when intermittent slightly overcast conditions were experienced.

In order to determine the effect of a late afternoon tidal inundation, one set of readings (24 January) was taken during spring tides. At high tide the base of the trees was inundated to a depth of 50 mm.

A comparison of transpiration rate between "wet" and "dry" sites was conducted with trees 40 m apart. The trees in the "wet" areas were growing in mud inundated frequently at high tide. The receding tide left the soil waterlogged with puddles on the surface. The salinity of the water in these puddles was approximately 30‰ apparently as a result of showers of rain. Moisture was thus freely available to the mangroves growing in this area. The trees in the "dry" areas were growing in mud overlain by sand and were inundated only during high spring tides.

RESULTS

Results revealed that the rate of transpiration increased until 10h00, after which there was a steady decrease (Fig. 1). However, variations from this pattern did occur as in one set of readings (22 January) there was a more gradual increase in rate which reached a maximum only at 12h00 (Fig. 2). A high spring tide had no effect in reversing the decrease in the late afternoon (Fig. 3). There appeared to be no significant difference in transpiration rate between trees growing in "dry" and "wet" areas (Fig. 4), although the latter trees were subjected to shallow tidal coverage at approximately 14h00.

DISCUSSION

The results of this work confirmed the findings of other workers (Lewis & Naidoo, 1970; Leshem & Levison, 1972) that transpiration reached a mid-morning maximum at approximately 10h00, after which there was a steady decrease. Research by Joshi *et al.* (1974) indicated that stomata of several mangroves were wide open until 10h00 and that thereafter stomatal apertures decreased. Although these workers did not study *Avicennia marina*, it is possible that the same behaviour could be revealed, accounting for the steady decrease in transpiration during the late morning and afternoon. Under the extremely hot conditions

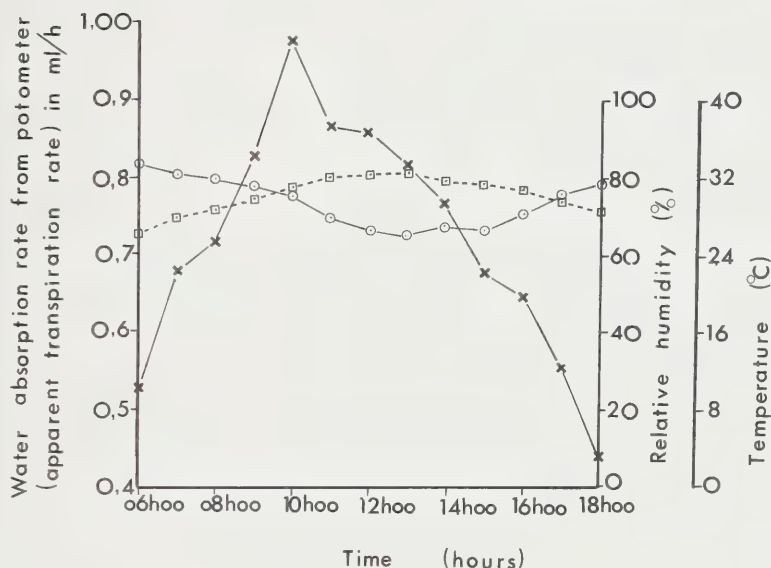


FIG. 1.

Mean relative humidities (○—○), temperatures (□---□), and apparent transpiration rates (x—x) of *Avicennia marina* on 16/1/1974. Neap tides, no tidal coverage, but water freely available in "wet" area.

prevailing at Inhaca in January, it would appear that the water potential gradient was so steep that the consequent high rate of transpiration induced an internal water deficit which resulted in the inception of stomatal closure. Although the significance of temperature was not unexpected, it was interesting to note the magnitude of its effect, for high temperature was of overriding importance. The water deficit induced by the high temperatures is obviously a very powerful regulator, as it caused stomatal closure even in bright light.

It is clear that after the inception of stomatal closure, the continuing high temperatures prevented stomatal re-opening even when water was freely available to the trees.

Lewis & Naidoo (1970) maintained that an incoming tide in the afternoon caused a temporary increase in transpiration, apparently as a result of the ready availability of water which enabled turgor to be regained and the stomata to open. The results at Inhaca showed no such temporary increase in transpiration rate with an incoming tide. The results on 20/1/1974 (Fig. 4), where a very shallow tidal coverage of trees in the "wet" area was experienced at approximately 14h00, did not reveal a significant increase at that time. This was not surprising as water had

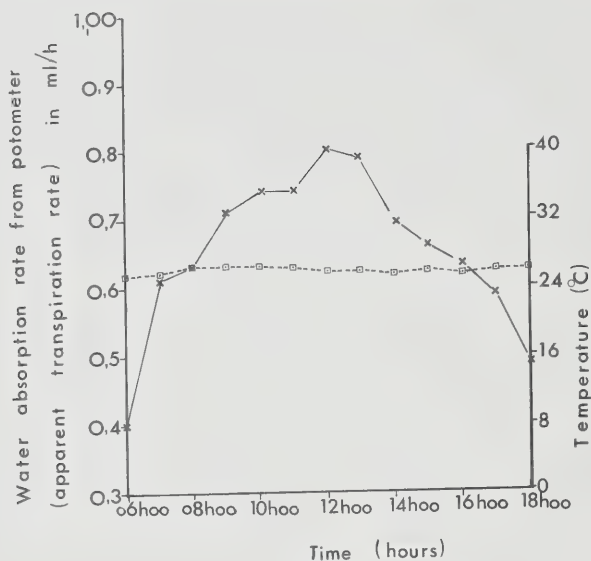


FIG. 2.

Mean temperatures (□---□) and apparent transpiration rates (x—x) of *Avicennia marina* on 22/1/1974. Start of spring tides, but no tidal coverage of experimental plants.

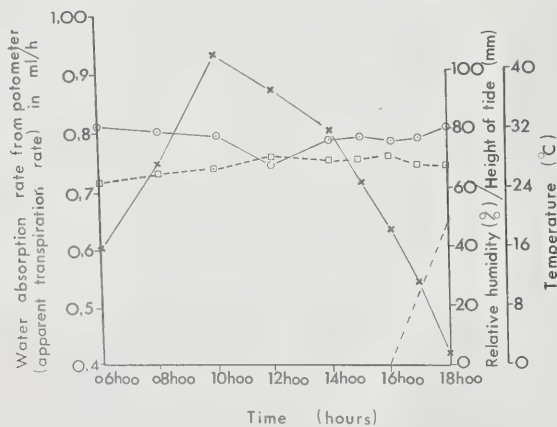


FIG. 3.

Mean relative humidities (○—○), temperatures (□---□), tidal heights (----) and apparent transpiration rates (x—x) of *Avicennia marina* on 24/1/1974. Spring tides, tidal coverage of plants.

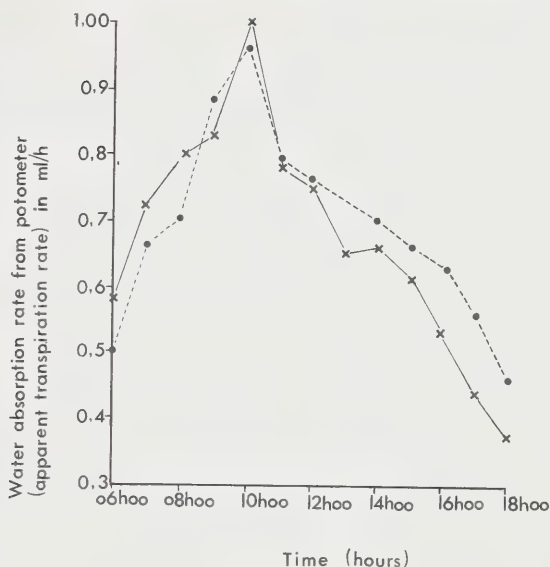


FIG. 4.

Mean apparent transpiration rates of *Avicennia marina* trees growing in a "wet" area (x — x) and in a "dry" area (●---●) on 20/1/1974. Shallow tidal coverage only in "wet" area.

been freely available to these mangroves prior to any tidal influence. The failure of an incoming tide to cause an increase in transpiration rate was further confirmed by the results on 24/1/1974 (Fig. 3). Although on the latter day tidal waters did not reach the mangroves until 16h00, sunset was at approximately 18h45, thus leaving at least three hours of daylight before darkness fell. During this period the rate of transpiration continued to decrease at a steady rate. On 14/5/1968 Lewis & Naidoo (1970) measured a tidal influence only at 15h30, while sunset on that day was soon after 17h00, i.e. only two hours elapsed between a perceptible tidal influence and darkness. In spite of this relatively short period, an increase in relative transpiration rate was still recorded by them. At Inhaca no increase in transpiration rate occurred when tidal inundation took place almost three hours before sunset. The lack of any effect due to freely available water was confirmed by the results obtained from plants growing in the "wet" and "dry" areas. Plants from both these areas revealed the typical pattern with no reversal of this trend being measured in the "wet" area.

It may be interesting to try to explain the reasons for the discrepancy between the results from Durban and Inhaca. Lewis and Naidoo (1970) suggested that in May stomatal closure commenced soon after 16h00 as tidal inundation later than

this time failed to prevent the decline in transpiration rate. It is difficult to believe in the light of evidence referred to earlier in this discussion that tidal inundation at Inhaca occurred too late on 24/1/1974 to prevent the decline in transpiration rate. Plants are unlikely to commence stomatal closure at a particular time throughout the year, rather might it be expected that plants would be able to compensate for daylength at different times of the year. Therefore, stomatal closure, in the absence of overriding factors such as high temperature which, it was suggested, caused early closing of stomata at Inhaca, would probably take place later in summer than in winter. Furthermore, the readings at Inhaca were obtained during January, probably the hottest month of the year, while the experiment at Durban was conducted during May which is one of the coolest months. Temperature recordings at Inhaca at that time of the year showed relatively little diurnal variation, reaching as much as 34 °C during the day. No temperature data are given for the period of the experiment conducted at Durban, but mean maximum and minimum temperatures for May are 24,2 °C and 12,9 °C respectively. Inhaca is closer by approximately 500 km to the Tropic of Capricorn than Durban Bay which is approaching the southernmost limit of mangroves in this country.

These results have indicated the need for more research on water relations in mangroves and for such work to be correlated if possible with observations on stomatal movements.

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